

AbstractID: 9224 Title: Improving accuracy of electron density measurement in the presence of metallic implants using orthovoltage computed tomography

Purpose: To evaluate the improvement in electron density measurement and metal artifact reduction using orthovoltage computed tomography (OVCT) imaging compared with conventional kilovoltage CT (KVCT).

Method and Materials: We constructed a bench-top CT imaging system with adjustable x-ray tube voltage up to 320 kVp. A commercial tissue-characterization phantom loaded with various tissue substitute inserts and two metal inserts – Titanium (Ti) and Aluminum (Al) were scanned using 125 kVp (KVCT) and 320 kVp (OVCT) x-rays, respectively. The metal artifacts are evaluated in two ways – visually in the constructed axial CT image and by the deviation of estimated electron density from true electron density for uniform materials outside the metal. The stoichiometric calibration curves were obtained for both KVCT and OVCT imaging system by following the Schneider method.

Results: The metal streak artifacts are seen to be reduced significantly in OVCT image than in KVCT image, especially in the area near Ti insert. The deviation of estimated electron density for the materials outside the metal are also reduced significantly by using OVCT than by using KVCT: from 42% (maximum) and 18% (root-mean-square) to 12% and 2.0% for heavy artifact area, and from 12% (MAX) and 3.0% (RMS) to 6.3% and 1.4% for light artifact area, respectively. The relationships between CT numbers (Hounsfield Unit) and relative electron densities (to water) are more predictable for both tissue substitutes and real biological tissues using OVCT than using KVCT. Unlike KVCT, the calibration curve for OVCT is insensitive to the tissue substitutes selected for direct electron density calibration.

Conclusion: OVCT may be a good option for high precision radiotherapy treatment planning, especially for patients with metal implants and especially for charged particle therapy, such as proton therapy.

Conflict of Interest (only if applicable): Collaborated with Varian Medical Systems.